Space Weather Technical Forecast

Issued on Tuesday, 08 March 2022 at 00:44 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance of isolated M-flares. Weak CME arrivals possible, with a chance of G1/Minor Storms mainly late day 3 (10th), possibly early day 4 (11th).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity was Low over the period, with two C-class flares observed in the 24 hour period. One flare observed at 07/1504 UTC from AR2961 in the southwest quadrant. Second C1.8 flare was observed from the bright flux region seen over the NE limb at 07/2250 UTC. There are currently six sunspots on the visible disc, which includes one new and un-numbered sunspot. The largest and most complex is AR2960 in the southwest, which is classified as a Ehi/Beta-Gamma configuration, although remains stable. AR2962 Cro/Beta is situated within a plage area, but with no notable flare activity. AR2961 Bxo/Beta in the southeast continues to show signs of decay. AR2957 in the southwest also shows signs of decay in its intermediate spots, and remains stable. AR2963 Bxo/Beta in the centre disc is newly emerged, along with a new and currently un-numbered sunspot to the south of this region. Both of these regions are small and simple Bxo/Beta configurations. A large filament eruption near the southwest limb lifted off around 07/1400UTC, which produced a CME, which is yet to be analysed, although given its location, this is unlikely to be Earth-directed. A filament eruption was observed in the area of ex-2958 in the northwest disc late on the 6th March, with a subsequent CME observed on both LASCO and STEREO-A coronagraph imagery. This has been assessed as having a potential Earth-directed component, with a glancing impact late on the 10th, or possibly early on the 11th. No other CMEs were in evidence in available imagery.

Solar Wind / Geomagnetic Activity: The solar wind, as measured by DSCOVR at L1, were at elevated levels, near 510km/s, during the start of the period, gradually declining to slightly elevated levels, ranging from 440-470km/s, before rising to near 500km/sby end of the period. Density was initially at or just above average, but declined to mostly below. The total Interplanetary Magnetic Field strength (IMF), Bt was weak, at below 6nT. The north-south component (Bz) was mainly negative, with brief positive rotations, varying between +2nT and -5nT. Phi angle was mainly negative (towards the Sun), with brief orientations to positive (away from the Sun). Geomagnetic Activity was Quiet to Unsettled (Kp1-3).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) measured at GOES 16 was at Background levels.The high energy electron flux (greater than 2 MeV) was mainly High, with a peak value of 10200pfu at 07/1520UTC, gradually declining back to below active threshold by the end of the period. The corresponding 24-hour integrated electron fluence rose above the Active (1e8 integrated pfu) threshold by 07/0000UTC, and remained above this level with an increasing trend. The 08/0000 UTC observation was 3.48e8 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to be Low to Very Low, with further occasional C-class

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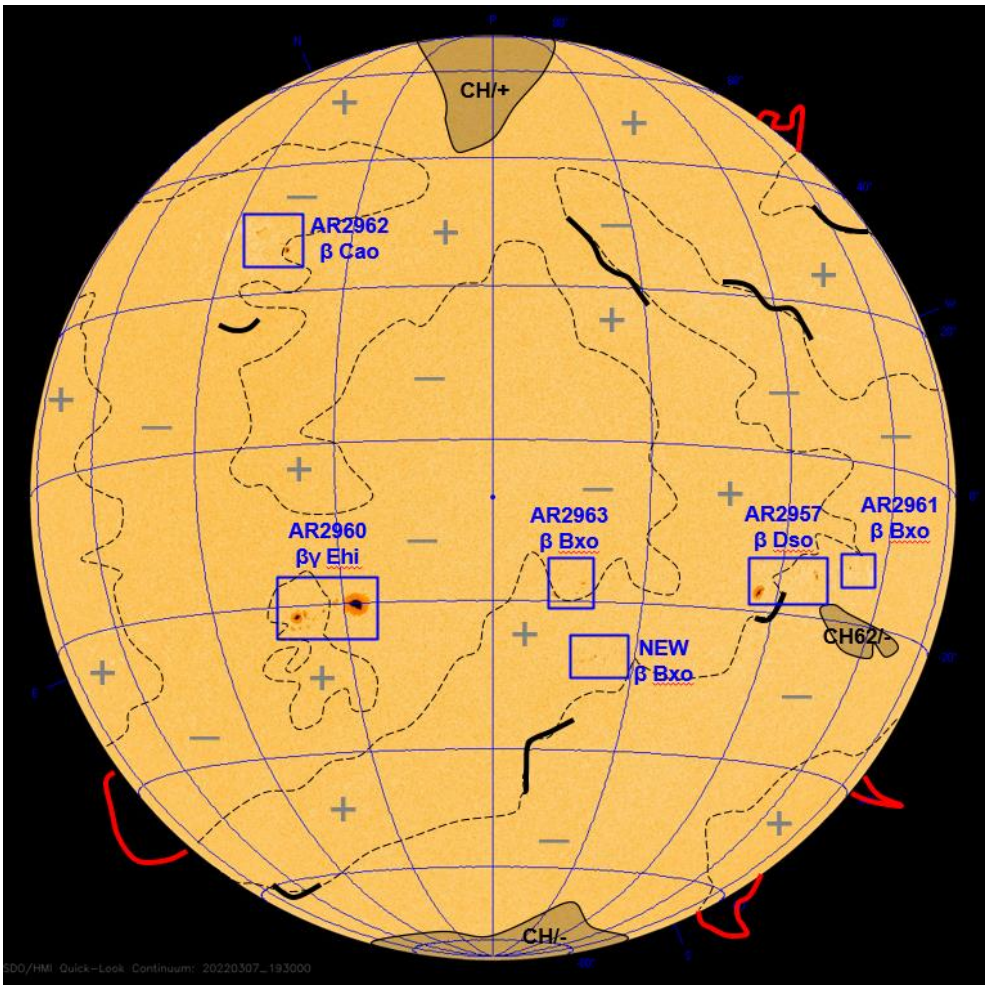
flares but with a chance of rising to Moderate from any M-class flares.
Solar Wind / Geomagnetic Activity: There are two potential CME arrivals in the forecast. Firstly, an observed weak CME could move through late on the 9th or on the 10th (day 2 or day 3), although this is low confidence as no source could be identified and the observed CME is very weak. The filament eruption CME on the 5th is then expected to arrive late on the 10th (day 3), or perhaps on day 4 (11th). Otherwise solar winds are expected to ease to background, with no coronal hole fast wind enhancements forecast. Geomagnetic activity is forecast to be mainly Quiet, with a chance of Unsettled intervals. Isolated Active spells are possible late day 2 or day 3 (9th and 10th) from any CME arrival. There is a slight chance of G1/Minor Storm intervals, mainly late on day 3 (10th) or possibly early on day 4 (11th) from the glancing arrival of the second CME.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to remain at Background levels. The high energy electron flux is expected to persist at High levels but with a chance of drop-out from any of the CME arrivals. This most likely to occur later day 4 (11th) with the arrival of the second CME (from the filament eruption 06/2245 UTC). The associated 24 hour fluence is expected to remain Active (above 18 integrated pfu) through the period, but with increased uncertainty towards the end of the period due to the potential CME arrivals.

Figure 1. Solar Analysis Valid 07/1930UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

The current fast wind regime is expected to gradually ease away through the period, with solar winds easing towards background and no further notable coronal hole source enhancements expected. However there are two potentially Earth-directed CMEs in the forecast.

The first is very low confidence due to the lack of a clear source and also faint signal in imagery, however, a weak CME was observed early on the 5th, heading NE on SOHO LASCO and NW on STEREO A, suggesting the CME is directed between Earth and STEREO A. This would bring a weak CME arrival either very late day 2 (9th) or on day 3 (10th). Both of these are expected to be either weak, or missing Earth and unlikely to bring notable enhancements to geomagnetic conditions.

The second is a filament eruption from the vicinity of ex-2958 in the northwest quadrant around 26/2245. The subsequent CME is a partial halo on LASCO imagery, and gives a glancing arrival late on day 3 (10th) or early on day 4 (11th).

Geomagnetic activity is forecast to be mainly Quiet through the period, with a chance of Unsettled intervals. Isolated Active spells are possible late day 2 or day 3 (9th and 10th) from any CME arrival. There is a slight chance of G1/Minor Storm intervals, mainly late day 3 (10th) or early on day 4 (11th) from the glancing arrival of the second CME.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	5	20	20
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
06/0650 UTC	Partial	Unknown	N04E15	224km/s	10/1200UTC	Very low confidence with uncertain source
07/0920 UTC	Partial	Ex-2958	N10W24	417km/s	10/2100 UTC	Good confidence, but only glancing impact likely.

Figure 2: MOSWOC Enlil and Ensemble.

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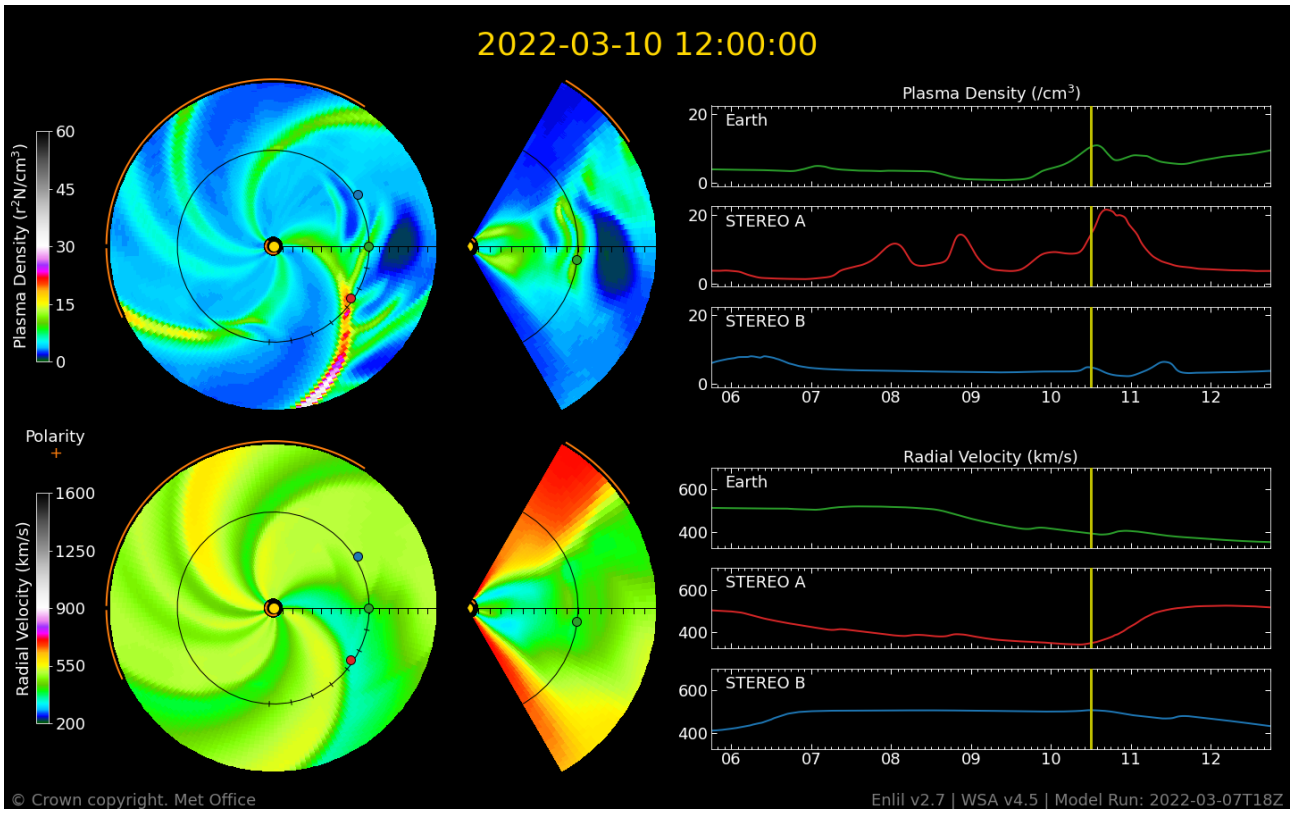

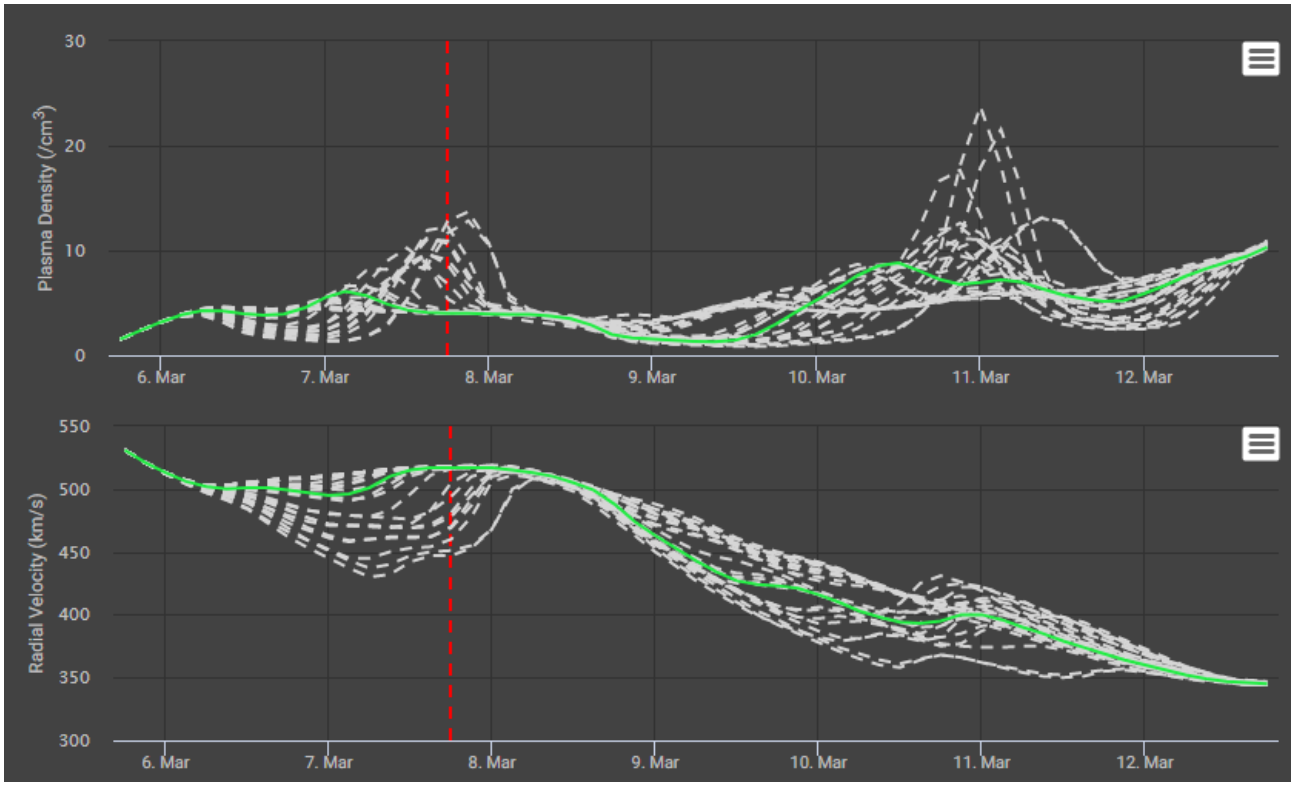

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Radio Blackouts - X-Ray Flares:
There are currently six sunspots on the visible disc, which includes one new and un-numbered sunspot. The largest and most complex is AR2960 in the southwest, which is classified as a Ehi/Beta-Gamma configuration, due to a negative spot emerging to the south of its trailing spot, but remains stable. AR2962 Cro/Beta is situated within a plage area in the northeast, which shows a lot of magnetic looping in SDO 171 imagery, but otherwise no notable flare activity. AR2961 Bxo/Beta in the southeast continues to show signs of decay. AR2957 in the southwest also shows signs of decay in its intermediate spots, and remains stable. AR2963 Bxo/Beta in the centre disc is newly emerged, along with a new and currently un-numbered sunspot to the south of this region. Both of these regions are small and simple Bxo/Beta configurations.

A further bright flux region is visible on STEREO-A EUVI 195 just over the northeast limb, with associated magnetic looping visible in SDO imagery. This could also be a source of potential flare activity as it rotates onto the disc during the next 24 hours.

Solar activity is currently Low, and is expected to remain Low to Very Low with any flares likely limited to C-class. There is a chance, however, for isolated M-flares (R1 Radio Blackout).

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	25	25	25	25
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 3: SDO/EUVI 195 imagery shows bright flux region approaching the NE limb – which has already produced a C1.8 flare.

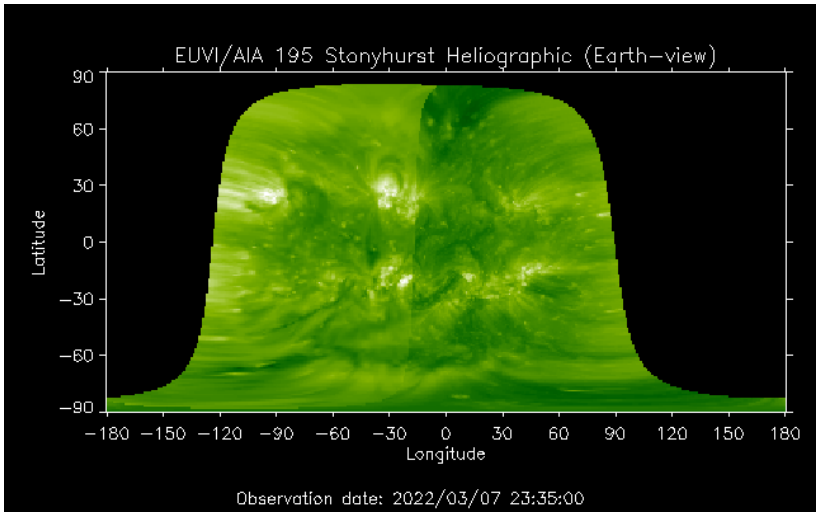

Figure 4: GOES-16 X-Ray Flares

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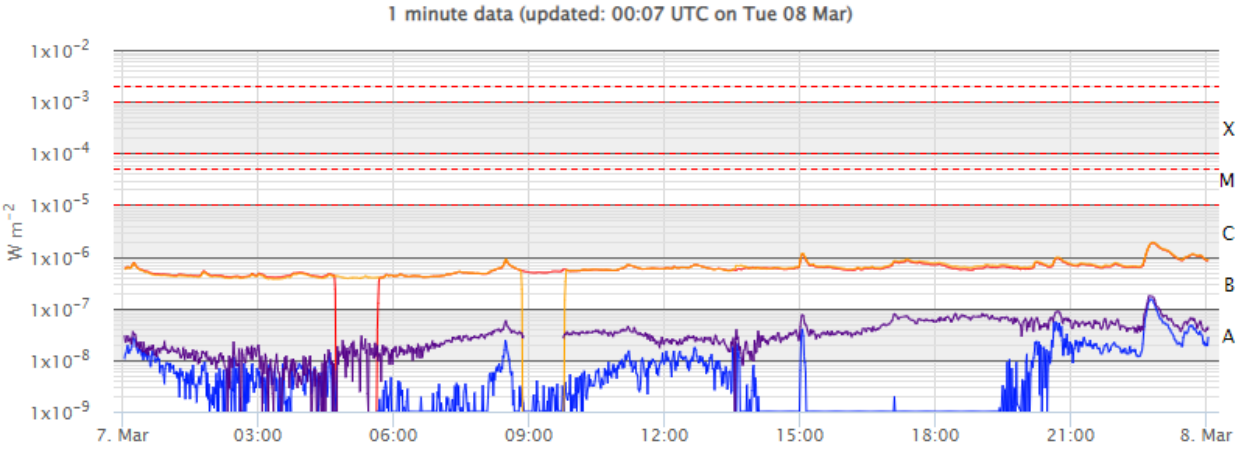

Solar Radiation Storms - (High Energy Protons):
The high energy proton flux (10MeV) measured at GOES 16 is currently at Background and is expected to remain at this level.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	1	1	1	1
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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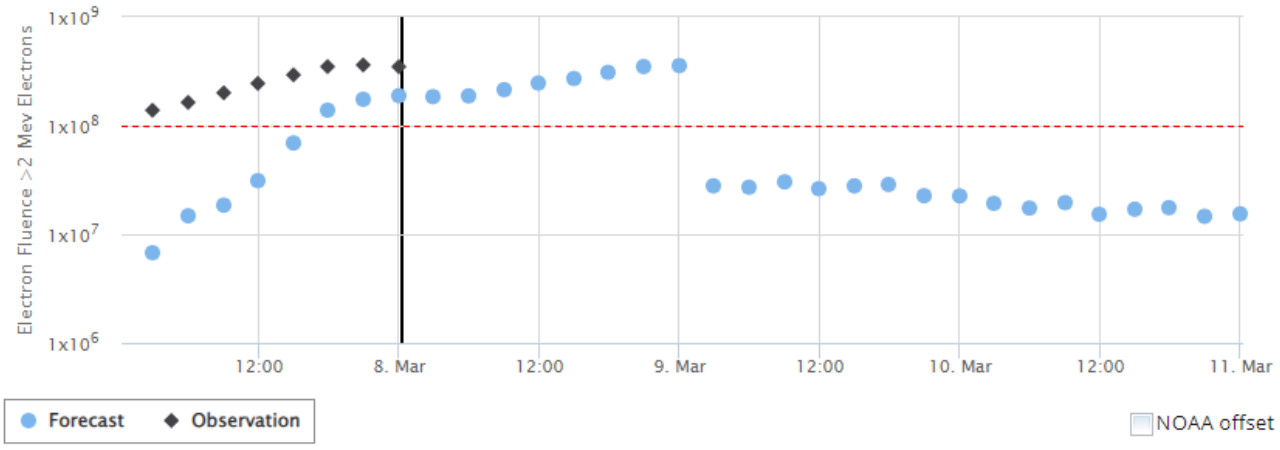
High Energy Electrons Event (≥ 2MeV):
The high energy electron flux (greater than 2 MeV) as observed by GOES-16 is currently High, due to the recent fast wind enhancements. These flux levels are expected to persist for much of the period, but could see brief dropouts from any glancing CME arrivals either later on day 2/day 3 (9th/10th), although these are low confidence. A more likely dropout is expected later on day 3 (10th) and into day 4 (11th) with a further CME arrival.

The associated 24 hour fluence is forecast to be Active (greater than 1e8 integrated pfu) for much of the period, but with an increasing chance of falling below from late day 2 (9th) onwards. This is supported by REFM for the next 24 hours, however beyond this period this model currently gives poor guidance due to current conditions not comparing well to the 27-day persistence.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	Yes	100	80	70	50
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 5: REFM fluence observations and forecast – currently above the Active threshold.



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